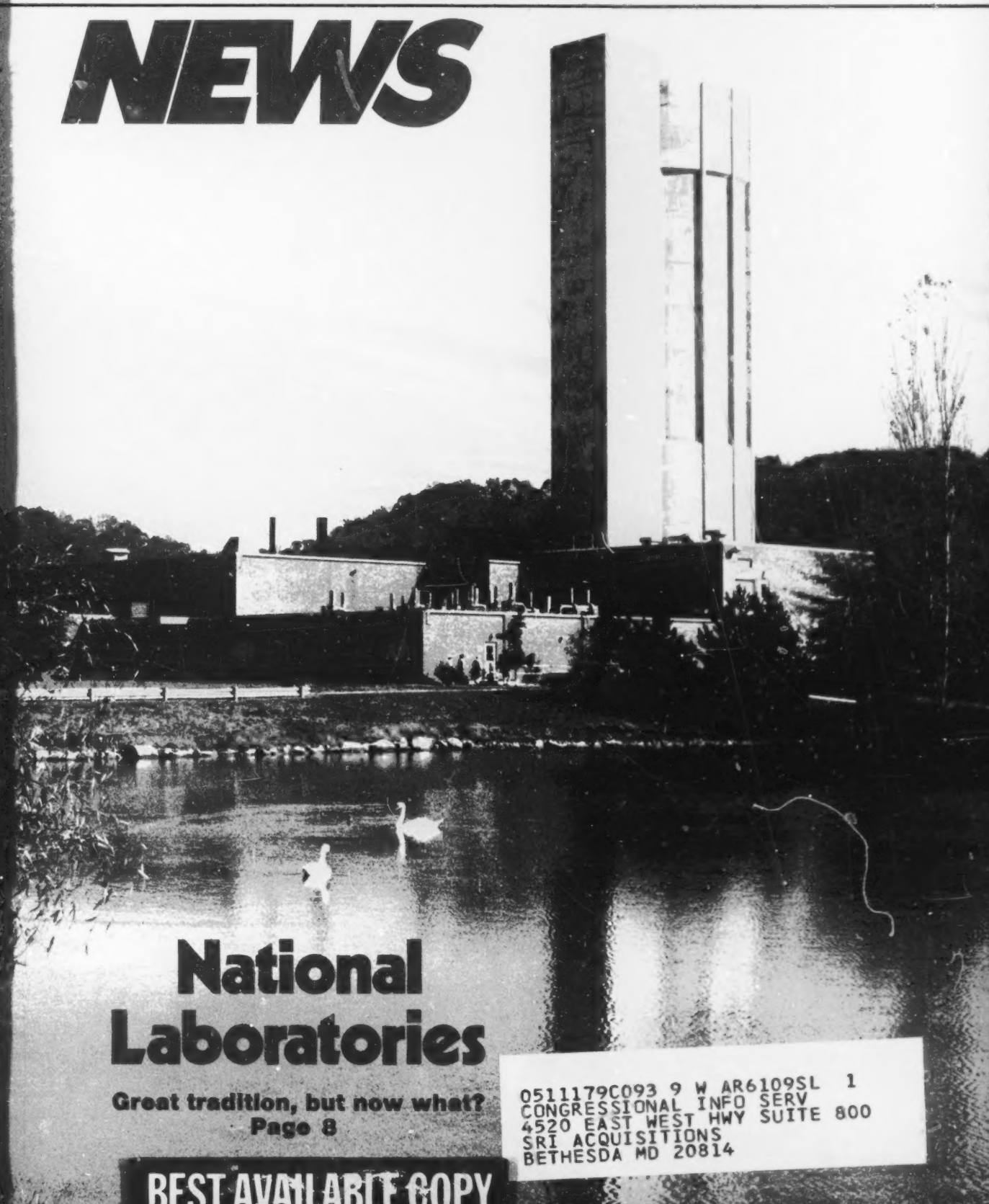


41257-1 3/1/83
FEBRUARY 28, 1983

CHEMICAL & ENGINEERING

NEWS



National Laboratories

Great tradition, but now what?
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News Focus

National laboratories, bastions of weapons development and industrial innovation, face reassessment of their reason to be. **Page 8**

Tradition-Rich National Labs Brace for Change

**Weapons development, industrial innovation are
now deemed sole priorities of labs; some question whether
new policies ignore long-term energy problems**

Wli Lepkowski, C&EN Washington

A little more than 40 years ago, the U.S. decided to build a revolutionary kind of bomb based on the power within the atom's nucleus. Thousands of construction workers, engineers, and scientists were recruited, and in three cities that were kept secret—Hanford, Wash., Oak Ridge, Tenn., and Los Alamos, N.M.—the work of making plutonium, separating uranium-235 from U-238, and building the bombs themselves began. By 1945 three "devices" were exploded, and the world knows the rest of that story.

Off of those three centers, and the Radiation Laboratory at the University of California, Berkeley, sprouted a group of eight large national atomic energy laboratories that marked the new "big science" era in government science and technology. The aims were to build ever-new types of bombs and missile warheads, tame the atom for peaceful uses, and to investigate the deeper secrets of the atomic nucleus. The dreams were heady and eventually reality took over.

Atoms for war meant a very precarious kind of security. Atoms for peace turned out to be more expensive and controversial than anyone thought in the beginning. The labs developed the light-water reactor, dropped other designs, and in retrospect failed to foresee and warn against serious safety and waste disposal complications that plague the nuclear industry today. As the environmental quality movement grew and flourished and the oil shock of 1973 shattered U.S. security over energy supply, the laboratories began showing a confusing and diverse image. Under the old Atomic Energy Commission these labs were fountains of new ideas and autonomous keystones of science and policy. But when the Department of Energy took over in 1976, their images became blurred and confused. Universities and government-supported research firms saw them more and more as competition for the scarce federal dollar, and the political sharks were sent out to dismember them.

More than a year ago, White House Science Adviser George A. Keyworth II sent chills through the laboratory community when he said publicly that it was doing a lot of unneeded research, especially in such areas as energy conservation, fossil fuel studies, and renewable energy sources. Keyworth said it should be directed to working on problems fundamental to industry. He feels that way even more today and points to the recently announced Center for Advanced Materials at the Lawrence Berkeley Laboratory as the emerging model. Materials scientists at universities are skeptical of the model and resent not being consulted while the center was being planned. But Keyworth and LBL director David A. Shirley are enthusiastic about the initiative, and the Administration is asking for \$192 million to start work on the new center, built around the lab's synchrotron light source.

So the future of the national labs is not really at stake anymore, but it does remain clouded. The Administration wants to abolish the Energy Department and move the labs to the Department of Commerce. Science Adviser Keyworth is causing shivers in the labs by challenging them to come up with programs as novel as Berkeley's materials center. Programs in fossil fuel research and soft energy innovations, begun with such enthusiasm during the Carter Administration, have kneeled before the budgetary axeman.

Brookhaven and Argonne for a while were fearing for their existence. Over the past two years, Oak Ridge has laid off 570 people, Lawrence Berkeley 640, Argonne 840. High-energy physicists at the labs are embroiled in a vicious debate over whether to stop work on Brookhaven's partially built Isabelle accelerator and start a new-generation machine someplace in the Southwest. Thus, the labs always have been centers of debate and probably always will be. All of which isn't bad. Three high-level panels have been assessing their nonmilitary work during the past year and their reports are beginning to come out.

"A lot of people in the labs are shell-shocked by all

National labs network focuses on big physics, weapons research

3. PACIFIC NORTHWEST

Founded in 1942 solely to produce plutonium in reactors for Manhattan Project. Experienced downturn in 1964 when plutonium production all but ceased. Battelle Memorial Institute took over and under special contract integrated its work with that of Atomic Energy Commission research at site. Chief current strengths are nuclear waste disposal, breeder reactor development. No significant ties with universities but a model of sorts in integrating a lab with a regional economy. Run by Battelle

4. LAWRENCE BERKELEY

Formed in 1943, lab is grandfather of national laboratories with origin in University of California, Berkeley, radiation laboratory where first cyclotrons were built. Considered to be model of national lab integrated with university. Now multipurpose lab stressing basic research that, in tradition of charismatic founder Ernest O. Lawrence (founder of Big Science), is seen as model of the power of physics and chemistry to help solve any problem. Run by University of California

5. LAWRENCE LIVERMORE

Weapons primarily, with significant effort (20%) going into magnetic and laser fusion energy. Founded in 1952 under influence of Edward Teller who wanted separate laboratory to compete with Los Alamos in weapons development. Operated by University of California

6. LOS ALAMOS

Birthplace of atomic bomb, continuing as primarily weapons laboratory with strong component in medium energy physics. Established in 1943 and run by the University of California

2. ARGONNE

Founded in 1946. Mainly reactor development; focus on breeder and other fission reactors. Basic research focus on general materials studies. Origin in University of Chicago metallurgical laboratory where in 1941 first chain reaction was demonstrated. Run by University of Chicago

1. BROOKHAVEN

Established in 1947 as East Coast center for high-energy physics research. Has other radiation-generating instruments for studying basic properties of materials. Strength is relations with universities in their use of big instruments. Operated by Associated Universities Inc.



7. SANDIA

Formed in 1945, mainly engineering for weapons development. Was devoted totally to weapons work until 1973 when it began diversifying into solar, fossil fuel, conservation, and nuclear energy development work. Operated by Western Electric

8. AMES

Founded in 1946, lab produced uranium for first chain reaction at Chicago. Research on ultra-high purity metals. At \$15 million budget, smallest of labs. Operated by Iowa State University

9. OAK RIDGE

Origin in University of Chicago metallurgical laboratory and founded in 1942 as Clinton Laboratory to serve as lab for magnetic and gaseous diffusion separation of uranium-235 from U-238. Most diversified of all labs with strong points in environmental sciences and biology (now both declining), and fission and fusion energy development. Like Lawrence Berkeley, has rich tradition in academic relationships though without immediate proximity with university. Now undergoing change in contractors (currently operated by Union Carbide nuclear division)

these investigations," comments Joel Snow, director of science and technology affairs of DOE's Office of Energy Research. "But maybe there will come out of all this a new appreciation for these labs for their place in the total system." What has been decided is that they are indeed important, even unique, technical resources that the country ought not to squander. But they are still felt to be victims of bureaucratic bungling and misdirection.

When the Atomic Energy Commission gave way to the Energy Research & Development Administration, and two years later to the Department of Energy, broad-scale funding ended and the labs had to begin seeking smaller contracts in various, often unconnected fields. Contract administration came under the different DOE operations

offices with the result that scientists had to deal with contract officers in both Washington and the regional operations offices.

"My concern," says Los Alamos director Donald M. Kerr Jr., "is if we allow lower tier government people to make decisions about the labs, it could result in less opportunity to use our technology to solve problems. We have 600 individual programs here, and that means there are 600 people in Washington who think they own a piece of the lab."

So the labs are currently being roundly assessed. But to Oak Ridge director Herman Postma, the assessments are at least helping to give high-level skeptics a sense of what the labs do offer the country. "One of the panels

ERAB report criticizes Energy Department management of labs

The report issued late last year by the Energy Research Advisory Board, although only moderate in its praise of the laboratories, did urge that they be served as important centers of research on national problems. What the panel is critical of, however, is the floundering system of support, management, and oversight by the Department of Energy.

DOE's management practices regarding the laboratories, it states, "are not consistent with their long-range future well-being and deny to the nation the full benefits of this national research and development asset." It goes on to say that although the Reagan Administration wants to decrease the types of federal R&D programs that private industry can do, there are potential innovations that industry will not work on. It says the laboratories could fill a legitimate slot in the national R&D picture with industry and the universities.

The question, of course, is how to achieve this systematic sleight of hand with DOE's reluctance to establish any overall management information principles. This is the summary of the report's findings and recommendations:

Direct functions. The laboratories should keep doing what they do best: research in high-energy and nuclear physics, nuclear medicine, generic energy research, and fields of research such as ecology and radiobiology that some of the laboratories established to

study the effects of radiation. Universities and industry should increase their participation in that activity.

Support functions. The laboratories act as agents to manage both complex projects and work they contract out to industry and universities. They give technical assistance to other agencies, to governments, and to industry. They are used to train students and faculty in the associated universities. They counsel and advise DOE on ongoing and emergency problems.

Technical capabilities. The panel calls them "impressive" but says DOE is inefficient in making best use of them. It says that funding policies are obstacles and the labs labor under much budgetary uncertainty. "Layering and fractionation of managerial and research and development responsibilities in DOE," it adds, "require labs to interact with DOE on an excessive number of horizontal and vertical levels and with heavy reliance on negotiation." There is need for a "coordination and resolution officer at DOE" at the deputy undersecretary level to decide where work is to be done and where it fits into the overall energy policy. The labs should be given two-year appropriations by Congress. Relations between labs and DOE regional operations offices should be at arm's length in policy and program development. The offices are too closely involved in the programs at the labs. Lab directors should be given more flexibility

to reprogram resources or start new programs at no less than 5% but no more than 10% of lab budgets.

DOE policies and procedures. The labs are burdened with too much paperwork. Still, research quality at the labs needs improving. Current DOE patent policy is too restrictive for effective technology transfer to industry. A paperwork audit should be done by an outside consultant to improve efficiency of operations. Technical audits of lab research programs also should be done by outside groups. Labs should be allowed to do more work for outsiders.

Lab involvement in DOE energy objectives. DOE has a vision of how labs could be used for research policy leadership. Lab staffs are not used in department planning. Lead mission assignments are ineffective and given reluctantly; DOE has no commitment to them. More training programs with universities are needed. Research and development at labs is not done enough with needs of end-user in mind. Technology transfer activities need a lot of improvement.

Other strategies for making best use of labs. Minimum funding will deteriorate the quality of research at the labs. If cuts have to continue, the best programs should be preserved. So options would be to give labs some work by other agency labs, narrow the missions of the labs, shut some down, or merge them with others.

that looked at us," recalls Postma, "derided us for being too diversified. We were working in energy conservation before it became a buzzword in the 1970s. The facts are that NASA's Jet Propulsion Laboratory at Caltech got \$70 million from DOE to work on solar energy and conservation, more money than any of the DOE labs had in nonnuclear energy. No one complained about a NASA laboratory being in the energy business. It galled me to see us chided for diversifying out of our interests when DOE money in our area of expertise went mostly to a non-DOE lab. But we are over that now. Still, it's hell to get beat over the head for just doing your job."

"DOE was very coherent in its projections for us five years ago," says James M. Williams, chief of planning and analysis at Los Alamos. "But since Reagan, DOE has had no clear picture of where we ought to go. So it has been a difficult time for us to plan because we don't know the response. So we've been emphasizing areas where we see the most growth potential—in the case of

Los Alamos, weapons work and such long-term areas as fusion."

"One of our problems," says another official at Los Alamos, "is that there are too many industrial concerns at the federal trough and they are competing with each other and with the labs. And in many projects it isn't clear that what they do is any different from what the national labs do. If we're going to be assessing the role of the labs we ought to be assessing the whole issue of federal funding rather than industrial relationships. Many contractors are producing useless gold-plated widgets for [the Department of Defense] or DOE and we ought to take a look at who those guys are."

The study panels are characterized by solid establishment figures. One group was assembled by the Energy Research Advisory Board (ERAB) and was headed by Ivan L. Bennett Jr., dean of the New York University school of medicine. It finished its work last September with release of its report. A second was organized by the

White House Office of Science & Technology Policy (OSTP) under David Packard of Hewlett-Packard. This group is assessing the future of all the national laboratories from health to agriculture, and a first draft of its report is on Keyworth's desk. The third is a subunit of the National Commission on Cost Reduction by Government. Its panel on energy, headed by Roger Milliken, chairman of the big, privately owned textile company, Deering Milliken Inc., has been looking into improving the efficiency of the labs in line with the Reagan Administration's smaller is better philosophy.

Although all the panels have finished their work, only the ERAB report has been issued. But what they each learned is that the laboratories as reservoirs of technical talent are indeed special.

Says Sandia president George C. Dacey, "I think the ERAB group finally came around to seeing the fundamentals it missed in its early investigations. Its final report was 180 degrees out of phase with its early draft. And I understand that reports being done by the General Accounting Office and OSTP are very similar in tone. They were first asking whether research and development should be the core in universities, industry, or the labs. In truth, there are industrial and academic labs that are indistinguishable from the national labs. It wasn't appreciated that a lab like Los Alamos or Sandia becomes an excellent institution over a number of years. It takes a lab that long to become a national resource."

Though bathed in myth and lore, the national labs are only latter-day entries into the federal government's research spectrum. Everyone has heard of the National Institutes of Health, national laboratories with a budget of \$3 billion. The Department of Agriculture pioneered the idea of the national laboratory geared toward practical needs. The National Bureau of Standards in the Department of Commerce is the one major national laboratory that directly serves industry and technology. The Bureau of Mines has long pursued the science and technologies of understanding and exploiting ores. More recently, the Environmental Protection Agency established a series of centers that grew out of vintage federal programs in sanitary engineering.

If, as the saying goes, the South can't eat magnolias in the face of meeting modern problems, the laboratories can't live off a past laced with the sense of hubris so characteristic of physicists. Today's buzzwords in science and technology policy are "innovation and productivity," on which the government speaks in rotund terms but still has no comprehensive policy. If that's the case, questions are raised over what role these laboratories have in contributing to the next era of U.S. science and technology with so many industrial and university research facilities competing for the same R&D funds. None of the centers were ever much of a focus for the economic development of regions through high technology, though each is located in the main geographic areas of the country. In short, there was little sense of integration with larger problems and now the fear is that history has passed them by despite individual zones of technical excellence at each lab.

"There are a lot of federal laboratories that could be shut down and nobody would know the difference,"

says one Congressional staffer who has viewed the parade of science policy fads and fashions over three decades. "I just can't get too excited about the issue. If I had my way, I'd have a sunset provision on them all. When they cease to fulfill their major missions, you close them down." And as for the argument that phasing them out would squander important talent and resources, this staffer sees such an argument as bunk. Good scientists usually can find good jobs.

The House Science & Technology Committee, ever alert in its search for issues to bring to its hearing rooms, will be continuing its series of inquiries on the laboratories this year. The first of them began in July of 1981 (The Future of the Department of Energy's Multiprogram Laboratories), continued through June 2, 1982 (Impacts of Budget Uncertainties of DOE's National Laboratories), and ended last December (The Future of DOE's Multiprogram Laboratories). The next chapter in the series will examine how well the labs are transferring their technology and science to social, economic, and industrial needs.

"I don't think you can overstress the importance of this national laboratories issue," says staffer Ezra Heitowitt, who once worked at Oak Ridge. "We really are at a point where people are concerned about the health of the U.S. technological enterprise and international competitiveness and we want to know how well science and technology are doing the job, especially in places where you already have a tradition of excellence. We want to know how you can make them more responsive. We want to look at how the government is removing the barriers to that transfer of technology."

One thing the committee will be examining is relationships of the laboratories with their contractors. Each of them is run by an outside group—Argonne by the University of Chicago; Los Alamos, Livermore, and Berkeley by the University of California Regents; Brookhaven by Associated Universities; Oak Ridge by Union Carbide; Pacific Northwest by Battelle Memorial Institute; and Sandia by Western Electric. The influence each contractor has over the program of the labs varies with the contractor. The University of California Regents pay close attention to programs at Livermore, Los Alamos, and Berkeley and do the actual choosing of laboratory directors.

One academic who knows at least one laboratory well is E. G. Meyer, vice president for research at the University of Wyoming. In the mid-1970s Meyer led a group of universities in the Western Mountain Region in an attempt to replace the University of California as Los Alamos' contractor. He felt the move made sense because Los Alamos was, after all, in their region. Because Los Alamos was diversifying, Meyer believed the new university arrangement would bring the laboratory more into the sphere of regional problem solving. As Meyer reports it, DOE sent the bid back with the envelope unopened. He is no fan of the labs.

"In fact," Meyer says, "the words 'national laboratory' injure me a little. These labs are funded by DOE and run by contractors. They are not national laboratories like the National Bureau of Standards or the Energy Technology Centers are. The words are used too much in the

Madison Avenue sense. They are very good, they have a lot of money. But they can't do everything by any means. There's no real external review of their programs."

Los Alamos did try to woo the universities in the region when its meson physics facility was built. "It wasn't until they wanted to build their accelerator and were facing competition from universities for the facility that they came to us," Meyer acknowledges. "So we joined forces in petitioning the Atomic Energy Commission to build the facility there." But as time went on, relationships soured.

"By the late 1960s, when weapons work began declining," Meyer says, "they began looking around for new projects. The trouble was that universities were moving in the same directions. So competition developed. The universities resented the fact that the labs were doing things the universities were staffed and able to do. They even branched into the socioeconomic area and contacted state agencies with proposals to do environmental impact studies for them. So the labs were getting away from their original mission, nuclear physics, and we didn't like it."

Laboratory/contractor politics is the hottest technical issue currently raging in Tennessee with the announcement by Carbide that they no longer are interested in running the Oak Ridge complex that includes the laboratory, allied weapons development, and uranium enrichment activities. The company has told DOE that it will run the facilities until 1986 if need be. But the bidding already has begun, with some 60 groups expressing interest. One of them is the University of Tennessee, which sees in such a contract both a financial and academic bonanza if it is selected. The university sees itself becoming a great research institution and has dreams of expensive \$100,000 distinguished Nobel Prize-level professorships funded through income from fees and overhead. DOE sources say the university's dream is of the pipe variety. Contractors, they say, don't make that much profit running a national laboratory. What the university would indeed gain would be adjunct laboratory facilities. Considerable University of Tennessee research is done at Oak Ridge, and several graduate students perform their thesis work in the Oak Ridge laboratories.

If each laboratory today lacks a discrete identity, there are moves to find for each of them one overriding national mission. The Energy Research Advisory Board's special panel on the multipurpose laboratories says DOE should seek for them a "broader laboratory role in innovation and productivity in the national economic interest."

But still needed is a basic federal concept in publicly supported research and development. Coming up with one isn't easy; but there are models. For example, the National Fertilizer Development Center run by the Tennessee Valley Authority in Muscle Shoals, Ala., directly engages in product development without interference from the Administration. The models being sought have more to do with developing methods of interaction between federal technical people and those in industry.

And the laboratories do here and there display models of laboratory-industry technology transfer. Oak Ridge, for example, is the leading laboratory for energy conservation (a concept not in favor by the Administration as a national laboratory activity). During the 1970s Oak Ridge engineers developed a water heater based on a heat pump as its source of energy. Oak Ridge asked Amana to look at it; Amana was impressed and obtained advance waivers from DOE on patent and licensing rights derived from work their employees did at Oak Ridge. They perfected the device and marketed it.

"Activities like this raise lots of questions," says Oak Ridge director Postma, "like why a sophisticated lab like ours is doing such a thing. Our role is that of agents for DOE policies." In the 1970s it was in fact DOE's policy to drive energy conservation technology into the private sector and it gave the labs the job. Now the policy has been turned around and made something the market itself should determine.

What the laboratories are doing now is establishing offices mandated by the Stevenson-Wydler Technology Innovation Act of 1980 to search out promising technologies and try to market them to potential industrial users. What is needed, all of the labs say, is a uniform patent policy at the department level that would give the laboratories the freedom to do more autonomous negotiating. What they want most is for DOE field offices to stay out of their hair.

One semisubversive way of keeping them out is through the Federal Laboratory Consortium, a network begun by Defense Department facilities to serve as technical shock troops whenever national, regional, or local problems erupt. Just as the Army or National Guard help out in emergencies, the consortium will call on scientists or engineers to offer their services. Staffers are allowed to devote 3% of their work time to the consortium, and some directors point to that activity as a form of technology transfer in the more public arena. The consortium was activated, for example, when the Three Mile Island crisis erupted in 1979. Countless smaller, less heralded examples also exist. But despite the existence of the consortium, one looks in vain for a sense of bureaucratic community among the labs. There is only scant dialogue among them. Directors usually meet only once a year, although there is more contact now that technology transfer is the current major concern at DOE headquarters. And it is rare that one gives credit to another for overlapping work done elsewhere. Los Alamos and Livermore are the best examples of open rivalry and jealousy. And on the more daily level, it was a surprise to some that during the press conference at which the Berkeley Lab announced establishment of its center for research on advanced materials, nothing was mentioned about the creative industrial participation around the synchrotron light source developed at Brookhaven.

But politics are a necessity when issues like saving the laboratory are paramount. And in politics one takes one's chances. The materials sciences community wasn't too happy about not being involved in the planning of the center. "Shirley was trying to keep alive his laboratory by inventing a bogus *raison d'être* around materials science," says Rustum Roy, head of the materials sciences

Focus of Pacific Northwest Lab is radiation research

The Pacific Northwest Laboratory began as the Hanford Engineering Works in 1943 and was one of the three "secret cities" involved in the development of the atomic bomb. More than 140,000 workers were involved in the construction of the reactors that produced plutonium between 1943 and 1945. Some stayed. Most stayed only a few weeks, succumbing to the isolated, shantytown, militarized life in what is in reality a desert in that part of Washington state.

Battelle Memorial Institute actually makes up only a fraction of the total technical force at the Hanford facility (known as the "Area" locally). Atlantic Richfield runs the nuclear waste reprocessing and storage program there; United Nuclear Industries operates the dual purpose nuclear reactor that produces Pu-239 and generates electricity for the northwest region; and Westinghouse operates the Hanford Engineering Development Laboratory, whose gem is the fast-flux test facility for research on the sodium-cooled breeder reactor concepts.

Battelle runs the laboratory in an arrangement that is unique among all the labs. Though they are all contractor-operated, the Department of Energy allows Battelle to use laboratory staff to work on projects funded by private Battelle contractors. The result is a seemingly complicated accounting system by which researchers and other personnel divide their work hours according to project. A chemist may simultaneously be studying nuclear waste disposal techniques under DOE funding and also be spending some time analyzing the properties of a new ceramic for an industrial client.

How this system came about goes



Olesen: operation works well for Battelle, DOE, and the region

back to 1964 when the test ban treaty drastically reduced nuclear testing. The result was the shutting down of nine of the 10 plutonium-producing plants and an enormous reduction of the work force. At the time, the so-called Tri-Cities area was wholly dependent on the Hanford works and a committee was formed to work out ways of preserving the scientific and engineering talent in the area. Battelle offered to come in and try to re-establish a technical base. The experiment worked, or has worked so far, and by that decision a national laboratory began playing a direct role in the sustenance of a regional economy.

Today, PNL does work on radiation effects on materials, radiobiology, terrestrial and aquatic ecology, atmospheric sciences, radiological physics, the beneficial aspects of radiation, nuclear waste management, reactor siting, and general energy development work. Like the forested environmental re-

search park at Oak Ridge, PNL operates a 110-square-mile arid lands ecology reserve in the Washington desert. Moreover, it is trying to help the Washington Public Power Co. deal with the \$10 billion financial disaster it is facing by stopping construction of three large nuclear power plants. This fiasco came about by poor planning and failure to anticipate the costs of construction and safety.

PNL's director, Douglas Olesen, sees the operation as a big success that works well for Battelle, DOE, and the region. PNL has yet to work out a system of technology transfer between the federally funded research and the private sector. One would think that Battelle, with its know-how in the patenting and licensing of research also would lend its talents to the government for that purpose. But either no one has thought of extending the philosophy to the patent field or the idea is simply seen as not feasible. Still, if the laboratories are contractor operated, DOE would appear to need to rethink the purpose of such an arrangement, especially if innovation and productivity are the new themes around federal laboratory research.

Olesen is impressed with the Energy Research Advisory Board report, but says he doubts that its major recommendations can be implemented. "Unless there's a massive overhaul of DOE," he says, "the idea of having an undersecretary in charge of the laboratories just wouldn't work. We have pragmatic assistant secretaries now who decide how the work gets done in various areas and how it gets funded. As long as those people have programs it would be difficult to have somebody else deciding how things would get done."

laboratory at Pennsylvania State University. "Everyone knows that the big movement today in materials is processing. And the real innovations in ceramics were, in fact, demolished in the national laboratories by this Administration."

The laboratories try to do technological transfer and succeed some of the time. However, there appear to be no firm principles of policy and action; no dialogue between business and the government's R&D sectors on the issue. No one appears to be taking the lead.

The situation is understandable, and Berkeley will be

encountering the problem soon enough when it tries to draw companies into the center. "Over the years," says George C. Pimentel, director of the Berkeley lab's Laboratory for Chemical Biodynamics, "it's been a traumatic business trying to get into this new world when it's no longer [possible] to say Berkeley is the world center of high-energy physics. So LBL is feeling out the ground in industry cooperation. I'm not sure we really know what we're talking about. I have people in the biodynamics lab who wanted to do an experiment with IBM in San Jose. The negotiations dragged on for a year and

Keyworth: labs should have set of missions conforming to national goals

White House Science Adviser George A. Keyworth II gives his views of the national laboratories in an interview with C&EN's Wil Lepkowski.

C&EN: Have you changed your attitude toward the labs since a year ago when you said there was a lot of work they shouldn't be doing?

Keyworth: No, and a lot of people studying the laboratories have come to the same conclusions. And that is that you have a resource making an enormous expenditure of federal dollars and, more important, an enormous assemblage of facilities and talents that could be used vastly more effectively to address the two top priorities of the country: to maintain our superior defense technology or perhaps to improve the competitiveness of U.S. industry.

C&EN: Over the past year, what's been done to bring that about?

Keyworth: We have made serious efforts in the budget to provide clearer missions by stressing areas that are

national priorities. But most of all we have tried to explain our policy as much as possible in the hope that the national laboratories would come up with their own mission and directions. And I would say that this has largely not happened. We're trying to create a model that we hope will have the input from the industrial sector as well as from the scientific community.

C&EN: Any other large thrusts in the labs?

Keyworth: I could point to a lot of small ones. But the main idea is that we are not going to turn two-generation-old institutions around as rapidly as the nation is changing. And we can't do it by pushing from the federal government. You've got to do it internally; you've got to do it by bringing industry closer and closer to the process in setting missions, directions, and priorities.

We have built since the Sputnik era an environment in which there's a widespread perception in academia and in many of our national laboratories that good creative research is inconsistent

with the profit motive. I think that's an attitude that's inconsistent with the fact that we're facing such strong challenges from Japan and Western Europe and even occasionally from the Soviet Union, so that if we don't optimize our own ability to innovate and improve technology then we'll start to lose, badly.

C&EN: Do you foresee any of the non-weapon laboratories being phased out?

Keyworth: I just don't think the political system would support that. What I think we will see is some laboratories being more responsive than others. Some will receive more impetus in establishing their new missions, like Lawrence Berkeley Laboratory is doing right now. If they do that well, and carry it out effectively, I think it will ensure a long duration of vitality. We are not in a period of unrestrained economic growth. We don't have money to burn.

C&EN: One of the problems in so-called innovative ideas is that, as the labs put

a half and IBM finally said they weren't interested anymore and they left. So that closed the door. Now we're trying to get the door back open through the university, and this brings in a different cadre of lawyers, those of the university rather than just DOE. If DOE wants these connections to happen, they'll have to agree to bringing it down to a two-party arrangement."

Warren E. Winsche, deputy director of Brookhaven, has a related view. "We are trying to evolve with a system that is changing, but we haven't come to grips with it yet," he says. "We got some money from Exxon. We like it but we're not going around asking for a lot of industrial money because companies always want to know what they are buying. At the same time, American industry is so internationalized that what they learn from us could easily go to a foreign government anyway."

Winsche, moreover, doesn't take too gloomy a view of the situation at Brookhaven. "We might be down now," he says, "but we're still much higher than we were the last time we hit bottom. In 1972-73 we were down to about 2400 people. Our current level is 3100." He does regret that Brookhaven's proposed research showcase, a Center for Structural Biology, was rejected by DOE; but he remains optimistic even though he expects as many as 200 more personnel cuts as DOE continues its cuts of fossil fuel, alternative energy, environmental, and biomedical research. "I don't think we

feel vulnerable," he says. "We have strong interaction with the universities and a growing interaction with industry." And although he couldn't get the biology center, there's a good chance DOE will give the nod to upgrading Brookhaven's research reactor, the only strong source of neutron beams in the country and with only one competitor, a reactor in Grenoble, France.

To debate the future role of the laboratories is to place oneself in the mainstream of debate about science policy and the social and economic future of the country. That's the kind of dialogue one might hear at the end of long discussions about high-flux test facilities or proton-proton colliding accelerators. But that may be the core issue that could determine their fate. In a technical world so internationally intertwined, a world where the U.S. is grudgingly admitting that the Japanese lead not only managerially but technically, one has to ask what the nature of the technological "competition" really means. There is little dialogue within the labs on this issue. In the weapons labs, the questions of national security revolve only around weapons superiority. But there is concern about America's "technical illiteracy" and the directors have no problems addressing that.

"Real or imaginary, some of us sense a public disaffection with science and technology," says Los Alamos' Kerr. "It's not clear whether the supply of scientists and engineers is affected. But if we think this generation of

It, they are restrained by the bureaucratic procedures at DOE.

Keyworth: You hit a nail on the head. It is a strange thing that the ideas and priorities used to come from the laboratories. And it worked. And today, they don't have as many ideas; when they do, they have to march through this excessive bureaucracy. I'm not sure how to walk backward in time, but I do know that the DOE bureaucracy is excessive. I do have some skepticism whether the government is capable of providing a sustained sense of clear direction. This is one of the reasons I keep harping on the fact that we need more industry involvement. We really do have a generation of leadership in high-technology industries that have a sense of vision. And I think those people should have brought more into the guidance and management process.

C&EN: Do you think the laboratories will establish marketing policies for moving their technology into the private sector? And how would one do that, given your feeling that the labs are

hindered in taking initiatives by the DOE bureaucracy?

Keyworth: Nobody ever gives the Administration much credit for this, but did you ever stop to think that we had a reason for dismantling DOE? We have built a monster. It neither handles operations of R&D effectively the way AEC did nor does it stimulate effectively energy development. It has become a large, unwieldy federal bureaucracy.

C&EN: What will OSTP's Federal Laboratories Panel say about the labs?

Keyworth: They will clearly talk about more explicit mission definitions, more involvement with industry in setting priorities; they will talk about more institutional independence in proposing means by which the missions can be met. Those are the big things. They will talk about developing the means by which performance is judged. We're months away from that report.

C&EN: There seems to be no tendency to look ahead and anticipate problems

among these labs. You'd think there'd be anticipatory studies.

Keyworth: I'd blame the Energy Department and ERDA for that. First of all, such an overhead of paperwork was created, so many studies done, that it was difficult to get people the credibility on the outcome of that study. Second, when you work for an agency whose mission is not taken as credible—such as the objective to meet 20% of the nation's energy requirement [by conversion] to solar by 1990—when such a technically infeasible objective is established, then it is not surprising that the labs find themselves embarking on paths that have very little relation to reality. So I think it's been a demoralizing experience for them. When they were building the atomic bomb, it was a very crisp, short-term goal, and they went at that with verve and imagination. By the time they got on to the energy mission the energy crisis was already over. The market was stabilized so that there was no longer a crisis and a lot of the vitality was lost. They're suffering now from the problems of old age.

kids standing before their videogames can lead into understanding of problems of the man-machine interface, we're kidding ourselves." It's that combined with the quick fix mentality.

Sandia's Dacey is concerned, too. "I think the antitechnology attitude in this country and elsewhere is destructive. It's hard to know why we are doing this. It was easier to understand during the 1960s when it was carried out by young people on the social fringes. But now you have institutions like the Catholic Church and the American Bar Association taking stands against military security. And most serious is that these positions are not informed. The people doing the most vocal lobbying don't have the facts straight."

Many high-technology presumptions do need examining, however. For example, one justification for nuclear energy development lies in citing the consequences of population growth around the world. The argument goes that the only way of solving human misery is in the supply of electrical power to the developing countries. The problem is that the developing countries are poor and nuclear energy is the most capital-intensive energy ever invented. They simply can't afford it, and in the future probably will be less able to do so. Yet no national laboratory is devoted to solving the energy problems of the developing countries in terms of the limits to capital. Indeed, those with projects

around alternative sources of energy lost their DOE support under the Reagan Administration.

"The big question," says science policy analyst Christopher Wright of the Carnegie Institution of Washington in Washington, D.C., "is to what degree basic and applied science supports the life support system." Wright, who grew up in Los Alamos during the bomb development work, says Washington technology policy planners scarcely know how to ask the questions in a systematic way, and the Reagan Administration believes documents like the Global 2000 report on technology's dangers to the environment are opposed to business and thus aren't worth considering.

Therefore, because the labs are multipurpose, the concerns they raise are multifaceted. The high-technology energy models that the developing countries are being forced to assume may simply not be the right ones. And the alternative models appear to be what this Administration wants least. Weinberg was once engaged in an interlaboratory conference on converting the labs to sociotechnical centers that would assess these issues. But nothing ever came of it.

A couple of the labs, for example, do look at, say, the effects of carbon dioxide on Earth's climate. But there is no systematic federal effort to deal with threats to the system as perceived by the highest expertise.

"Every new technology," says William Marcuse, head

All laboratories except weapons facilities at Los Alamos, Livermore, and Sandia are experiencing manpower cuts

	Budget ^a (\$ million)		Staff size ^a		Scientists/ engineers ratio	Approximate % of budget 1982 ^a			
	1979	1983	1979	1983		Weapons	Nuclear energy	Basic physics	Biology/ environment/ basic energy sciences
Argonne	\$280	\$252	5070	4230	5/3	1%	36%	3%	28
Berkeley	141	132	3070	2430	7/3	2	1	37	25
Brookhaven	162	210	3520	3220	7/3	0	1	39	30
Livermore	396	730	7010	7380	8/5	51	20 ^b	neg	4
Los Alamos	398	576	6800	6900	2/1	48	7	8	5
Oak Ridge	313	366	5000	4430	3/2	9 ^c	40	21	22
Pacific Northwest	122	153	2100	1830	5/3	17	25	0	31
Sandia	489	900	7600	7950	3/5	67	5	0	7

^a Fiscal year. ^b Fusion. ^c Imprecise: Oak Ridge National Laboratory serves as backup for uranium production and enrichment work done at Oak Ridge complex. neg = negligible.
Source: Department of Energy

of the office of research and technical assessment at Brookhaven, "has associated with it lots of problems. There are health problems associated with production, environmental problems with waste, both health and environment with disposal of these products. The strange thing is that this Administration refuses to see those issues as a component of science policy. A coordinated research policy would have to include the biomedical, economical, and ecological impacts of what we are doing. Another thing the Administration refuses to do is to generate a research policy that anticipates all of these elements. As it is, we remain much too discipline-oriented in a time when so many problems are related."

And Sandia's Dacey's concern about the powerful rise of antitechnology forces within established institutions could be off the mark. Sophisticated scientists do think that the lab directors could be less hawkish on matters of national security. One of them is Hugh DeWitt, a plasma physicist at Livermore.

"Lab management considers me a pain in the neck," DeWitt admits. "My interest has always been more in basic physics than in weapons. I've been out to improve the scientific climate at this lab because the problem with Livermore is that it has become more and more an engineering lab. And the University of California Regents take no role in establishing the policies."

But what disturbs DeWitt most is the lack of internal debate over the implications of the arms race. "The Regents are no help there, either," he says. DeWitt says the laboratory directors play too heavy a role in arguing for extensions of arms buildup.

"During the 1977-78 debate on the arms limitation treaty, Energy Secretary James Schlesinger became worried that it would pass, and he brought Roger E. Batzel (director of Livermore) and Harold Agnew (then director of Los Alamos) to Carter to urge him to keep testing. This made a lot of us quite sick. But they've been

doing this since 1957. These directors enjoy great influence in Washington. They have a strong vested interest in continuing weapons work. They oppose any realistic arms limitations schemes. People who rise up in lab management take the hawkish orientation and they believe the way to national security is to have an impregnable offense.

"I'd like to see the university have more say in the policies of these labs. I agree that the University of California is probably the best institution to operate these labs. If they were run by someone else there might be less public scrutiny of what they do. The university at least has a tradition of encouraging free debate and controversy and protecting its faculty, even though at a place like Livermore the management would rather not have people like me around. Most of the research and development people are simply high-level technicians who give little thought to the dangers of what they are doing."

Former Livermore director Herbert F. York, now a professor of physics at the University of California, San Diego, thinks that in the absence of any creative dialogue on arms control, the labs should continue to be doing exactly what they are doing. The people at the labs do participate in dialogue on arms control and national security, he says, but only in the context of current strategic nuclear policies. There are nonmilitary threats to security, of course, but he thinks that other institutions are better adapted to studying such dangers as overpopulation and food supply.

The national laboratories are a collection of a lot of talented people who have been in the middle of many controversies over the years. As Alvin W. Trivelpiece, director of DOE's Office of Energy Research, says, "By and large it's better that there be a little trauma than just having a static situation. It makes for more dynamic institutions." For the labs' critics, the issue is more than dynamism. It's more like a guiding vision. □

Chlor-Alkalies Begin Long Climb Up From Recession

Badly battered in 1982, chlorine, caustic soda, and soda ash face slow growth; for chlorine/caustic, more plant shutdowns are likely

Bruce F. Greek, C&EN Houston

U.S. producers of the major chlor-alkalies—chlorine, caustic soda (sodium hydroxide), and soda ash (sodium carbonate)—knew business had weakened a year ago (C&EN, March 1, 1982, page 10), but they expected a pickup later in the year. Instead, things got even worse.

Unbelievably, plant use for chlorine/caustic sank to 60% and even below, an astounding level for plants traditionally run from 80 to 95% even in bad years. Output fell 15% from 1981. Prices remained shattered in chlorine and fell back from dizzy heights for caustic soda.

In soda ash, the new prosperity from heavy investment in natural

product facilities in Wyoming had to take a breather. Here, the mine use rate retreated to 75% in 1982, output dropped 6% from 1981, and prices finally gave ground.

Chlor-alkali producers believe they hit bottom at last about the end of 1982 and finally can move up again this year. However, it will be slow going.

Growth rates predicted for the rest of this decade are no better than the

the lead. This could produce the same shortfall and high prices for caustic supplies as before the 1982 recession. High caustic prices could then help soda ash producers in their campaign to displace caustic in various uses.

For now, such efforts to gain market share are on hold like everything else in the business, including expensive technology switchovers and capacity additions. The overriding objective for 1983 and 1984 is basic recovery in business volume. Later in the decade, money may become available for the important technical and capacity advances producers would like to make.

Instead, capacity shakeout is the trend of the moment. How much electrolysis capacity in chlorine/caustic will be shut down permanently is the big question. Some analysts estimate that as much as 700,000 tons per year of capacity (about 5%) will be taken off the list this year for lack of profitability. More could follow in 1984.

Longer term, unless product value and profitability rise, many more plant shutdowns could be coming. For chlorine and caustic, as much as 2 million tons per year of capacity could remain unneeded through the end of the decade.

For soda ash, the situation is not nearly as severe, but new technology may still force changes. Specifically, a general switch to coal-supplied energy and to solution mining, both potentially important efficiency boosters in trona mining, could sound the death knell for any other U.S. soda ash production. Internationally, U.S. soda ash could then become so cheap that politically erected barriers to it abroad would simply be overwhelmed.

For the more immediate market outlook on the major chlor-alkalies, see the following pages.

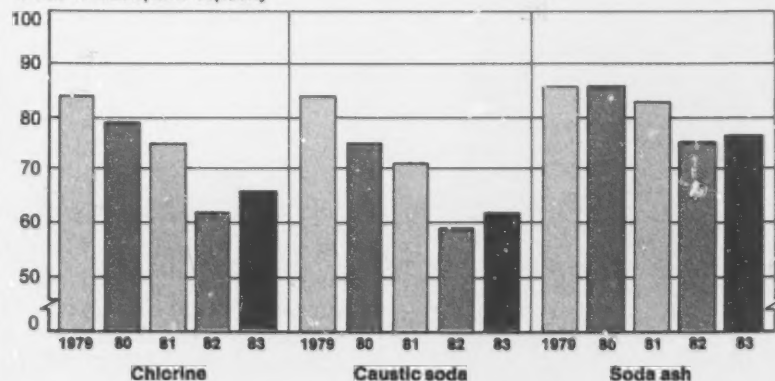
Key Chemicals

1970s for these slow-moving commodities. For example, the large capital outlays of the past five years in soda ash could yield average annual production growth of just 1.5%, say pessimists. Maybe 3%, say optimists.

Coming growth rates predicted for chlorine and caustic soda are no better, about 1 to 3% per year. A small demand differential is likely to continue between the two with caustic in

Plant use levels could edge up in 1983

% use of nameplate capacity



Source: Industry and C&EN estimates, Chlorine Institute, Bureau of Mines

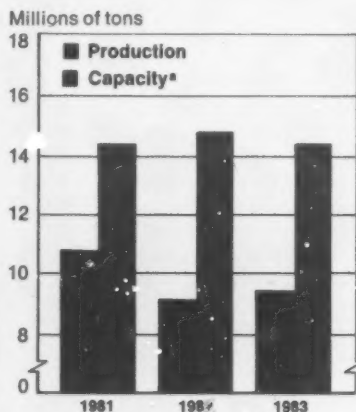
Key Chemicals

Chlorine



- **Output at bottom**
- **Capacity down**
- **Drastic price discounts**

PRODUCTION/CAPACITY



HOW MADE

Electrolysis of NaCl brine; recovery from hydrochloric acid; coproduction with metals; electrolysis of KCl brine

MAJOR DERIVATIVES (U.S.)

Ethylene dichloride 20%, other C_1 , C_2 hydrocarbons 10%

MAJOR END USES (U.S.)

Organic chemicals and plastics 70%, pulp and paper 10%

FOREIGN TRADE

Negligible

PRICES

List price \$145 per ton on Gulf Coast; discounting general and severe

COMMERCIAL VALUE

\$1.25 billion for production, 1983

The historical downturn in chlorine's fortunes that began in the mid-1970s shows little sign of a letup in 1983. Already shaken before the 1982 recession, chlorine took a fearsome beating last year, with prices discounted as much as half or more. The product's capacity-building wave of recent years finally ended, and the new economic reality forced producers into the first round of plant shutdowns. More closings are in the works this year in the face of a mild recovery pace.

For 1982, U.S. chlorine production totaled some 9.2 million tons, down 1.5 million tons from 1981 production, or 14%. This percentage decline was exceeded only once in recent decades, when in the 1975 recession production dropped 15%, according to the Chlorine Institute.

Analysts' outlook for 1983 varies widely depending on assumptions about the strength of the economic recovery now under way. As with many other big-volume chemicals, the divergence of opinion is causing more uncertainty than usual about chlorine volume. Current forecasts for 1983 production range between a small upturn of 2% to 9.4 million tons to a 17% rebound back to 1981's 10.8 million tons.

However, unless recovery becomes much more vigorous than it is now, the chlorine production gain likely will stick to the low end of the scale, according to most industry sources. Rising demand for chlorine in derivatives, pulp and paper manufacture, and water treating—the traditionally important uses—will lift chlorine output modestly. But inventory rebuilding isn't expected to be a big additional production booster.

Operation at chlorine plants fell below 60% of nameplate capacity for parts of 1982. Unfortunately, capacity hit the highest level ever in February 1982 at 40,700 tons per day, according to the Chlorine Institute. The inevitable followed, and capacity fell over the rest of the year by a bit more than 1000 tons per day. Even with this decline, the industry's operating rate slid off during the year. Obviously, closings did not keep pace with the production sag, which in December was still 10% from December 1981.

Under pressure of reduced demand, additional chlorine capacity now has

been shut down. Estimates of total shut-down capacity are about 2000 tons per day, bringing operating capacity to about 38,700 tons per day or somewhat below 14 million tons per year. During 1983, more capacity might be shut down, as much as 2000 tons per day, say some industry sources.

These shutdowns definitely will pick up chlorine operating rates this year, especially if demand improves more than pessimists expect. For example, if capacity stayed flat in 1983, the operating rate would be 67% of capacity to produce 9.5 million tons of chlorine. If capacity declines to 36,700 tons per day (13.3 million tons per year), the use rate could rise to 72%. Additional gains would come in capacity use in 1984 if demand edges up another 2 to 3%.

Chlorine's demand slump in 1982 came from the slump in demand for derivative chloro-organic chemicals, most importantly polyvinyl chloride. This drop exacerbated a general demand reversal since the mid-1970s. Before then, a shift in the chlorine use pattern to greater dominance by derivatives aided the rapid growth of chlorine capacity. However, in the late 1970s and 1980s, consumers turned away from many products containing chlorine or made using chlorine. The result today is a slump leading to capacity shutdowns. The consumer switch probably won't change chlorine's use pattern much but won't help demand growth either, according to the near-term outlook from one industry analyst.

Uses of chlorine other than chloro-organics also are struggling under the recession. For example, chlorine's market in wood pulp and paper is staggering under paper's competition from plastics in packaging uses. Chlorine also suffers from lower consumer demand for brightness in paper. Competition for chlorine from other bleaching materials in paper waxes and wanes with economics. On balance, this competition generally is considered less difficult to meet than is paper's challenge from plastic as packaging.

So for 1983, chlorine producers have reconciled past ambitions with the current reality of a modest recovery following a severe downturn. Capacity shakeout and patience will be the most likely tactic this year.

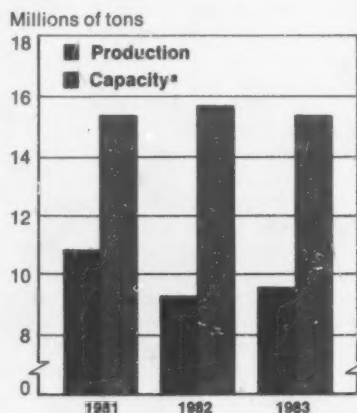
Key Chemicals

NaOH

Caustic Soda

- **Demand weak**
- **Capacity shaved**
- **Prices hauled down**

PRODUCTION/CAPACITY



* First quarter.

HOW MADE

Electrolysis of NaCl brine

MAJOR DERIVATIVES (U.S.)

None

MAJOR END USES (U.S.)

Chemical manufacture 50%, pulp and paper 20%, soap and detergents 5%

FOREIGN TRADE

Exports—easing to about 1 million tons in 1983; imports—rising to more than 100,000 tons

PRICES

List price about \$230 per ton for 50% liquid; discounting significant

COMMERCIAL VALUE

\$2.25 billion for production, 1983

Chlorine went from bad to worse in 1982 but never was expected to do well. For coproduct caustic soda, however, 1982 was a true shock.

Caustic started 1982 in such tight supply—squeezed by production constraints from chlorine—that price increases seemed a way of life. But all that came to an end. Caustic producers found their favored product turned into a shambles later in the year. At present, prospects are dim for a return to prosperity in 1983.

The list of negatives for caustic in 1982 grew lengthy. In about six months' time, caustic went from allocation among customers to oversupply. List prices fell a fifth or more in the last half of the year. No longer could coproduct chlorine ride on caustic's strong prices, and hard-pressed producers tried to raise chlorine prices at the very time demand was weakening. Caustic's price weakness also was a heavy blow in producers' shift from capacity buildup to capacity reduction.

Production of caustic soda dropped dramatically in 1982 to a bit below 9.3 million tons, down about 15% from 10.9 million tons produced in 1981. The decline for caustic runs larger than for chlorine because caustic is practically all produced from electrolysis of brine, whereas some chlorine is produced by other methods.

And as with chlorine, nameplate capacity for caustic is back to where it was at the beginning of 1981, 15.4 million tons per year. Along with chlorine, caustic is in line for further capacity decline. About the only possibility for expansion is in small plants with new, more energy-efficient cell membranes designed for remote location and in special uses such as in-house production at a pulp mill.

For 1982, caustic production ran at an average rate below 60% of nameplate capacity. Prospects are that this rate will climb back over 60% in 1983 because of a small increase in demand and declines in capacity.

The upturn in caustic demand this year would follow a general upturn in the chemical industry. Other chemicals make up half the U.S. use of caustic, although not very much caustic appears in the final product. Most caustic used in chemicals acts as a carrier or neutral-

izer just as in all but a small percentage of caustic's other uses. Most of caustic's large exports are consumed the same way, for example in making alumina from bauxite.

Chemical uses of caustic in turn vary as consumer demand affects end products. For example, aluminum demand has been hit hard by higher prices and recycling. Hence, consumption of caustic in both U.S. and export markets to make alumina probably will not grow in 1983 as will caustic's overall neutralization uses. Many of the latter are spurred by environmental concerns reflected in process design improvements, in part the result of statute changes.

Some of these environmental uses of caustic can be satisfied with unfinished caustic liquor straight from the electrochemical cells. This caustic doesn't go through the usual further processing to remove chloride ion and evaporate some water, and may not be reported in official production data. This practice accounts in part for the lower than stoichiometric ratio of caustic to chlorine in production figures. Though hard to pin down, these environmental uses of caustic are expected to continue to grow faster than the average for caustic markets in 1983.

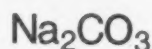
A wide variety of organic chemicals are made using caustic. Prospects for those uses differ, but in general this group is expected to grow at a rate above average for caustic. The large size of this group and its expected growth are behind some analysts' views that caustic could turn tight again later in the economic recovery.

Pulp and paper uses of caustic will stay below caustic's average growth rate because of paper's expected slow recovery from the recession. Recycling of paper and competition for caustic here from soda ash also could tend to dampen growth.

Most other uses of caustic likely will average 2 to 3% growth in 1983 and are not expected to change much later on.

During the rest of 1983, overall caustic use will recover at a pace almost in step with chlorine. This might firm up sagging prices a bit, but the net financial return from electrolyzing brine will provide little profit for producers of caustic and chlorine.

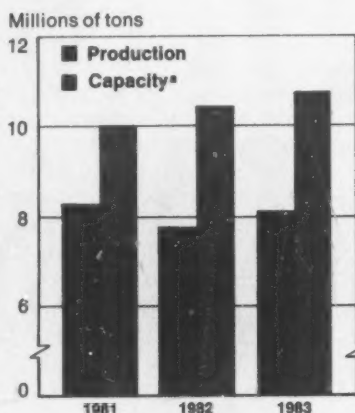
Key Chemicals



Soda Ash

- Demand recovery due
- Capacity on hold
- Prices still weak

PRODUCTION/CAPACITY



HOW MADE

Recovered from trona ore or brine; synthesized from salt and limestone using ammonia

MAJOR END USES (U.S.)

Glass 55%, chemical manufacture 20%, pulp and paper 5%, soap and detergents 5%

FOREIGN TRADE

Exports—rising slightly to more than 1.1 million tons in 1983; imports—negligible

PRICES

List price \$84 per ton at Wyoming mines; about \$40 higher in eastern U.S.

COMMERCIAL VALUE

\$700 million for production, 1983

Soda ash has been one of the hotter investment corners in U.S. basic chemicals and has producers excited about prospects later in the decade, when some experts expect U.S. production to dominate world supply (C&EN, Feb. 14, page 23).

But such heady visions don't apply to 1983, just as they didn't to 1982. True, soda ash got through the recession in 1982 in better shape than its alkali cousin, caustic soda. And soda ash also rates higher than caustic in a 1983 recovery.

However, soda ash production still declined about 6% to 7.9 million tons in 1982 from 1981 just as a major new producer, Tenneco, joined the ranks. For 1983, producers expect to recover more than half of this output decline, bringing production to about 8.1 million tons. Unless something very bad happens in exports, the rest of the 1982 decline probably will be regained in 1984.

Capacity moved up in 1982 as the new Tenneco mine and processing plant in Wyoming were completed. Startup of this plant boosted production to create inventory as well as initial volume for sales. However, offsetting Tenneco's output were reductions at other plants due to slowing sales.

For all of 1982, operable capacity apparently ran at about 75% of the nameplate total. This operating rate was down from 1981 but was still good compared to other big-volume chemicals, notably competitor caustic soda. For 1983, the operating rate will be nearly flat because of the 1982 capacity expansion.

The effect of a second straight year of lower operating rates on older plants making soda ash from brine or salt/limestone (Solvay process) opens a bag of speculation. Should the last of the synthetic soda ash plants in the U.S., Allied's at Syracuse, N.Y., be closed, and brine operations at Kerr-McGee at Searles Lake in California be reduced more, then the plant operating rate could get significantly higher—possibly to 85%. However, such changes still may take some time, just as with large potential capacity expansions in Wyoming resulting from development work on lower-cost solution mining of trona ore. Because of current overcapacity and

recent dampers put on European sales of imported soda ash, capacity expansion of any kind will remain on the shelf for 1983 except for small additions resulting from improvements in energy and other process efficiencies.

Domestic and export growth for soda ash will continue steady but at low levels after initial recovery from the 1982 recession, analysts predict. The 4% growth in production expected in 1983 will be above the long-term trend, estimated at 1.5% annually. Such a low rate is the result of problems in most major U.S. end uses and exports.

Exports are potentially handicapped by foreign politics and unfavorable economics, according to industry sources. For example, dumping duties in Europe against U.S. soda ash, and the strong dollar relative to other currencies combine to hamper U.S. exports. This year exports still are expected to grow by a small amount from 1982—perhaps 50,000 tons or 4 to 5%—to about 1.15 million tons.

Uses in the U.S., dominated by glass manufacture, face competitive problems, although of a different kind. Glass container markets are hard pressed by improved plastic resins and composites. In particular, soft drink bottles seem in more trouble than ever in 1983.

But plastic containers are only one part of the glass market problem for soda ash. Success is growing in glass recycling, bringing more glass back for reuse as cullet, and further reducing the need for soda ash. Cullet is expected to continue to grow slowly as a material for new glass.

By contrast, flat glass markets finally could give soda ash a lift. Badly hurt by the recession in auto and construction outlets, flat glass is expected to pick up during 1983.

Chemicals manufacture and detergents rank next to glass in importance among uses of soda ash. Again, recovery in demand for various inorganic sodium salts should help soda ash.

Another rising market hope for soda ash producers is to capture markets held by caustic soda in making chemicals and detergents. However, lowered demand and prices for caustic have put a damper on soda ash substitution at the moment, even though soda ash prices also dropped in 1982.

Canadian chemical firms hope slide is over

For Canadian chemical companies, the bad news is that most of them lost money in the fourth quarter of 1982. The good news is that they lost a lot less than they did in the disastrous third quarter.

As a result, Canadian chemical leaders are hoping that 1982's fourth quarter marks the turning point for recovery. Analysts seem to agree that the slide in corporate profits appears to be over. But it will be some time before Canadian chemical companies will be able to regain their earnings peaks of 1980.

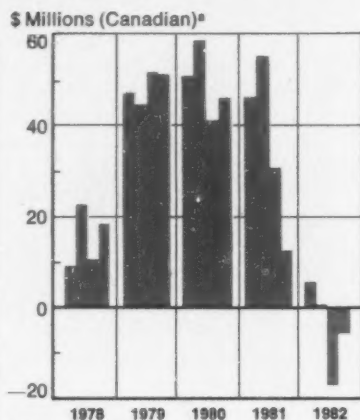
Certainly, 1983 figures appear to be much better than 1982 in both chemical sales and earnings. It could hardly be worse. Last year, for instance, the combined sales of four large, publicly reporting companies (C-I-L Inc., Celanese Canada, Du Pont Canada, and Union Carbide Canada) fell 12.5% from 1981's \$3.5 billion (Canadian dollars used throughout this article) to just over \$3 billion. The earnings picture is even worse. These four companies earned a combined \$144.3 million in 1981. Last year, they lost \$15.7 million.

The reasons for this disastrous performance are, by now, all too familiar. The Canadian economy was a shambles last year. As a result, domestic chemical demand was down.

Meanwhile, lower worldwide demand coupled with intense competition for international markets put a crimp in Canada's all-important chemical exports. They fell 11.6% to just over \$4 billion.

In the face of this lower demand at home and abroad, Canadian chemical companies couldn't raise prices. Yet, Canada's energy pricing policies

Combined earnings in red in last two quarters



* After-tax earnings of four largest publicly reporting Canadian chemical companies—Celanese Canada, C-I-L, Du Pont Canada, and Union Carbide Canada.

saddled them with much higher feedstock costs. Under these circumstances, it was inevitable that earnings would shrink and, in many cases, disappear.

Union Carbide Canada, for example, lost \$17.9 million last year on sales of \$691 million. It was the first loss in the company's 75-year history. Domestic sales dropped 14%; exports were off one third. Company chairman John S. Dewar says that the drop in sales was mostly in volume. Prices remained unchanged while costs increased about 10%.

Dewar says that a major factor in Union Carbide Canada's poor 1982 performance was the higher raw material costs that it had to pay as a result of Canada's fixed schedule of oil and natural gas price increases. And whereas Canadian chemical

companies had to cope with these increases, costs were going down for their counterparts in the U.S.

Dewar's sentiments are echoed throughout most of the Canadian chemical industry. Even in C-I-L, a diversified company and the only one of the four major chemical companies to show a profit last year, the 1982 earnings picture was bleak. C-I-L sales fell 7.8% last year, but profits plunged a hefty 72% to only \$15.2 million.

With the exception of industrial chemicals and crop protection products, all of C-I-L's business units recorded sales below 1981 levels. Company president and chief executive officer C. H. (Chuck) Hantho says, "The reduction in sales, combined with higher wages and salaries and increased costs of energy-related raw materials continued to have a severe impact on earnings." Those lower earnings led C-I-L to omit dividends in the third and fourth quarters of 1982.

Feedstock costs also come in for a large share of the blame for Du Pont Canada's 1982 operating loss. The company suffered a net loss of \$7.4 million on sales of \$980 million. Company president J. E. Newall notes that Canadian polyethylene producers are suffering from a significant feedstock cost disadvantage compared with U.S. competitors. U.S. producers, he says, have "used their advantage to reduce prices and capture a larger share of world markets." Although Du Pont Canada's selling prices in the fourth quarter were down 2%, on average, they were down 16% for polyethylene.

Canadian chemical companies have responded to their predicament by delaying or canceling capital spending plans. Layoffs are common throughout the industry.

As a result, many companies think that they will be leaner, tougher, and better able to cope with the recovery when it comes. Noticeable recovery, however, may not come until the second quarter of 1983.

Meanwhile, some Canadian chemical giants are in big financial trouble and may not survive unless they get some government help. This could take the form of relief from oil and gas taxes or direct financial aid.

Earl Anderson, New York

Canadian chemical sales and earnings suffered last year

\$ Millions (Canadian)	FULL-YEAR 1982					
	Net sales	Change from 1981	Net income ^a	Change from 1981	Profit margin ^b	
					1982	1981
C-I-L Inc.	\$1,059.8	-7.8%	\$15.2	-72.0%	1.4%	4.7%
Celanese Canada	323.9	-13.2	-5.6	def	def	5.5
Du Pont Canada	980.0	-14.0	-7.4	def	def	2.9
Union Carbide Canada	691.3	-16.4	-17.9	def	def	4.4
TOTAL	\$3,055.0	-12.5%	-\$15.7	def	def	4.1%

^a Net income from continuing operations, excluding extraordinary gains or losses. ^b Net income as a percentage of sales. def = deficit.

Academic Gap Between High and Low Achievers Narrowing

Study shows that in the 1970s academic gains in reading by some low achievers was offset by declines in science and math skills of high achievers

A recently released study by the National Assessment of Educational Progress has found that students with poor academic track records made some large gains in reading during the 1970s and held their own in science and mathematics. Most encouraging, NAEP says, are the improvements for black low achievers, who in elementary and junior and senior high schools increased their mathematics performance, and in grade and junior high schools also improved in reading. But at the same time, significant declines in mathematics and science skills were posted for academically able teenagers.

Earlier studies already had documented that grade school students had improved their reading abilities in the 1970s, that junior and senior high school students had declined in mathematics skill, and that senior high students had declined in science performance. But NAEP wanted to probe more deeply.

Explains Beverly L. Anderson, director of NAEP: "We wanted to determine whether students at different achievement levels experienced the same kinds of changes in performance."

NAEP has been carrying out assessments of educational achievement in various areas since 1969. It is funded by the National Institute of Education and administered by the Education Commission of the States, a Denver-based compact of member states and territories for political and

professional cooperation in planning for U.S. education.

Learning areas assessed include reading, writing, mathematics, science, citizenship, social studies, literature, art, music, and career and occupational development. In these assessments, NAEP has surveyed the attainments of nine-, 13-, and 17-year-olds, and all areas have been reassessed to detect any important changes. Test items, or exercises, are readministered to the same age group, not to the same people.

The exercises are developed through a consensus process. Over a period of several years, many educators, scholars, and lay persons from across the U.S. design objectives for each subject area, proposing general goals they believe Americans should be achieving through their education. Writers use these objectives to create specific exercises appropriate to the objectives. The exercises then must pass extensive reviews by subject-area specialists, measurement experts, and lay persons.

The exercises are administered to probability samples. The people in the samples are selected so that the assessment results can be generalized to an entire national population—the probable performance of all nine-year-olds in the U.S., for example, based on the performance of about 2500 nine-year-olds in a given exercise. The last science assessment, in the 1976-77 school year, involved about 80,000 students, each taking one of 31 45-minute packages of test items.

For its current, post hoc analysis, NAEP used only two assessments in each of the learning areas: 1972-73 and 1976-77 for science; 1972-73 and 1977-78 for mathematics; and 1974-75 and 1979-80 for reading. It analyzed the data in several ways: by group—black students and white students, for example—and also in terms of students' performance by achievement class and by modal grade.

Achievement classes were determined by partitioning students into

Analysis by age shows performance gains by lowest achievers along with decline by highest achievers. . .

Change ^a	Age 9 Lowest		Age 13 Lowest		Age 17 Lowest	
	Lowest	Highest	Lowest	Highest	Lowest	Highest
Reading	6.0% ^b	1.4% ^b	1.4% ^b	-0.3%	-1.0%	-0.4%
Science	1.0	-2.5 ^b	1.5 ^b	-2.5 ^b	0.6	-3.0 ^b
Mathematics	1.1	-3.0 ^b	1.2	-3.4 ^b	-1.2	-4.3 ^b

... and analysis by modal grade shows similar pattern of gains, declines in lowest and highest achievement classes

Change ^a	Age 9 4th Graders		Age 13 8th Graders		Age 17 11th Graders	
	Lowest	Highest	Lowest	Highest	Lowest	Highest
Reading	6.1% ^b	1.4% ^b	1.7% ^b	0.4%	-0.1%	-0.5%
Science	1.4 ^b	-2.4 ^b	1.7 ^b	-2.5 ^b	0.1	-4.2 ^b
Mathematics	0.4	-3.1 ^b	1.1	-3.4 ^b	-1.5	-4.3 ^b

^a National mean percentages of changes in performance. ^b Statistically significant, as defined by standard convention whereby differences between statistics are designated as significant only if the differences are at least twice as large as their standard errors.

quartiles of low achievers, mid-low achievers, mid-high achievers, and high achievers. This analysis provides additional insight into achievement, since both black and white students, for example, are in all of the achievement classes.

The modal grade is the grade in which the majority of students of a particular age are enrolled—the fourth grade for nine-year-olds, the eighth grade for 13-year-olds, and the 11th grade for 17-year-olds. NAEP points out that modal grade data are especially useful when juxtaposed with national data for age populations and the reporting groups within them. For example, age data indicate that certain groups—Hispanics, blacks, those attending school in disadvantaged urban communities, and several others—tend to perform at levels below the national average in reading, science, and mathematics. However, a disproportionate number of these students are found below modal grade as well.

Analysis of the data by achievement class shows that although low achievers by definition do not do as well as high achievers, the gap between them appears to be narrowing. In reading, both low and high achievers at age nine improved significantly. Among 13-year-olds, less able students scored higher in reading than those assessed five years earlier, while academically adept students showed no change. Neither high nor low achievers at the senior high level showed any significant changes in their reading skills.

Mathematics and science performance of students in the bottom quartile did not change between assessments, with the exception of 13-year-olds, who improved in science. However, the mathematics and science skills of high achievers at all three ages declined.

Analysis by modal grade and group (black and white) shows that among both low and high achievers, black students in the modal grade were more likely than white students in the same grade to show gains, although overall performance of black students remained below that of their white counterparts. More specifically:

- Black low achievers in the modal

grade for their age group improved in reading at ages nine and 13 and improved in mathematics and remained stable in science at all three ages.

- White low achievers in the fourth and eighth grades improved significantly in reading and science and held their own in mathematics. But the performance of less academically inclined 17-year-olds in the 11th grade declined in reading and mathematics.

- Black high achievers at grade level for their age registered gains in reading and mathematics at age nine and in reading at age 13. However, mathematics skills for both 13- and 17-year-olds declined, as did science abilities at age 17.

- White high achievers in grades four, eight, and 11 did not improve in any of the three subjects. They

maintained the status quo in reading, but mathematics and science performance declined significantly at all three ages.

NAEP convened a panel of experts in education and social trends to explore why these results had occurred. Some observations by the group are that compensatory education programs flourished in the 1970s, partly as a result of federal initiatives. At the same time, support for science programs dwindled, and mathematics didn't get the emphasis reading did. Moreover, teachers in these subjects were in increasingly short supply. And high school graduation requirements in both science and mathematics were relaxed. Finally, the popular back-to-basics movement often focused on lower-level skills, perhaps at the expense of a challenge for more able learners. □

SCIENCE

Syringe pump injects hormones periodically

A difficulty associated with the care of hormone-deficient patients is that treatment usually calls for repeated injections at regular intervals. A new device engineered at the U.K.'s Medical Research Council overcomes that problem.

It consists of a pump that exerts pressure on the plunger of a syringe at preset times. A specific quantity of hormone-containing solution is forced through a narrow plastic tube, the tip of which is embedded under the patient's skin. The lightweight unit is about the size of a packet of king-size cigarettes. It usually is strapped to the upper arm, and the wearer is hardly aware of it.

The device, which is not yet commercially available, is the brainchild of Howard Jacobs, a research endocrinologist at London's Middlesex Hospital. "At present we are using it for women who can't ovulate because there is something wrong with the hormones that drive the ovaries," he says.

He and his patients are delighted with the results. A number of women who were thought to be infertile became pregnant, and several births have resulted.

In some cases, infertility in women stems from lack of pituitary gonadotrophic hormones—follicle-stimulating hormone and luteinizing hormone—normally secreted in response to specific hormone-releasing factors from the neighboring hypothalamus. Previously, the condition has been treated with clomiphene. This analogue of chlorotrianisene, a nonsteroidal estrogen, stimulates increased secretion of the pituitary gonadotrophins by blocking the negative feedback receptor sites in the hypothalamus. But multiple ovulation, with multiple pregnancy, can occur.

With the new pumping unit, gonadotrophins are injected 16 times a day, "which is actually what is needed for this kind of treatment," Jacobs notes. And because administration can be controlled with precision, multiple pregnancies should be eliminated.

Jacobs and his team are testing the units with a group of infertile men who have a similar hormonal problem.

Children with hormone-related puberty problems also could benefit from the treatment. □